4. PRODUCTION, IMPORT/EXPORT, USE, AND DISPOSAL

4.1 PRODUCTION

Ethylbenzene is primarily produced by the alkylation of benzene with ethylene in liquid-phase slurry reactors promoted with aluminum trichloride catalysts or by vapor-phase reaction of benzene with dilute ethylene-containing feedstock with a boron trifluoride catalyst supported on alumina (EPA 1987c; HSDB 1995; Ransley 1984; Sandmeyer 1981). Other methods of manufacturing ethylbenzene include preparation from acetophenone, dehydrogenation of naphthenes, catalytic cyclization and aromatization, separation from mixed xylenes via fractionation, reaction of ethylmagnesium bromide and chlorobenzene, extraction from coal oil, and recovery from benzene-toluene-xylene (BTX) processing (HSDB 1995; Merck 1983; Ransley 1984; Sandmeyer 1981). Commercial grades of ethylbenzene may also contain small amounts of *m*-xylene, *p*-xylene, cumene, and toluene (HSDB 1995).

Ethylbenzene production in the United States has shown a steady increase from 1983 through 1994 (C&EN 1994a, 1994b, 1995a, 1995b). Production for this period was 7.9 (1983), 7.6 (1984), 7.4 (1985), 9.0 (1986), 9.3 (1987), 9.9 (1988), 9.2 (1989), 8.4 (1990), 11.4 (1991), 11.1 (1992), 11.8 (1993), and 11.9 billion pounds (1994) (C&EN 1994a, 1995a; USITC 1987, 1994). Ethylbenzene production capacity also increased slightly from 1988 to 1992. Annual U.S. production capacity reported for 1988, 1990, and 1992 was 9.5, 11.5, and 12.5 billion pounds, respectively (SRI 1988, 1990, 1992). More recent information on production capacity was not located (SRI 1994, 1995, 1996). In 1994, ethylbenzene was ranked 19th among the top 50 chemicals produced in the United States (C&EN 1995a).

Currently, there are 11 major producers of ethylbenzene in the United States. These producers include Amoco Corporation of Texas City, Texas; ARC0 Chemical Company of Channelview, Texas; Chevron Chemical Company of St. James, Louisiana; Cos-Mar Company of Carville, Louisiana; Deltech Corporation of Baton Rouge, Louisiana; Dow Chemical U.S.A. of Freeport, Texas; Huntsman Chemical Corporation of Bayport, Texas; Phibro Energy USA, Inc. of Houston, Texas; Rexene Corporation of Odessa, Texas; Sterling Chemical, Inc. Texas City, Texas; and Westlake Styrene Corporation of Lake Charles, Louisiana (SRI 1996). Of the 11 major U.S. producers currently manufacturing ethylbenzene, 4 companies including ARC0 Chemical Company, Cos-Mar Company, Sterling Chemicals, Inc., and Dow

4. PRODUCTION, IMPORT/EXPORT, USE, AND DISPOSAL

Chemical U.S.A. produce 20, 16, 13, and 13%, respectively, or a total of 62% of the ethylbenzene manufactured in the United States (SRI 1996).

Table 4- 1 lists the facilities in each state that manufacture or process ethylbenzene, the intended use, and the range of maximum amounts of ethylbenzene that are stored on site. There are currently 921 facilities that produce or process ethylbenzene in the United States. The data listed in Table 4-1 are derived from the Toxics Release Inventory (TR196 1998). These data should be used with caution however since only certain types of facilities are required to report (EPA 1995d). Therefore, this is not an exhaustive list.

4.2 IMPORT/EXPORT

In 1978 and 1981, $153x10^7$ kg (33.7 million pounds) and $2.09x10^7$kg (46.1 million pounds), respectively, of ethylbenzene were imported into the United States (HSDB 1995). More recently, U.S. imports of ethylbenzene have fluctuated greatly from 1991 through 1995 (USDOC 1996). Import volumes were $37x10^6$ kg (81.57 million pounds), $3.1x10^6$kg (6.83 million pounds), $5.3x10^6$ kg (11.68 million pounds), $35.5x10^6$ kg (78.26 million pounds), and $25.1x10^6$ kg (55.34 million pounds) for 1990, 1991, 1992, 1993, and 1994, respectively (USDOC 1996). Import volumes for ethylbenzene have been relatively small typically representing 1% or less of the annual domestic production volume.

U.S. exports of $8.59x10^7$ kg (189 million pounds), $4.84x10^7$ kg (106 million pounds), and $7.49x10^7$ kg (165 million pounds) were reported for 1978, 1983, and 1985, respectively (Bureau of the Census 1985; HSDB 1995). More recently, U.S. exports of ethylbenzene have steadily declined from 1991 to 1995 (USDOC 1996). Export volumes were $87x10^6$ kg (191 million pounds), $54.9x10^6$ kg (121 million pounds), $15.8x10^6$ kg (34.8 million pounds), $28.3x10^6$ kg (62.4 million pounds) and $9.5x10^6$ kg (20.9 million pounds) for 1990, 1991, 1992, 1993, and 1994, respectively (USDOC 1996). Export volumes for ethylbenzene have been relatively small typically representing 1% or less of the annual domestic production volume.

4.3 USE

Ethylbenzene is used primarily as a precursor in the production of styrene (ACGIH 1986; Merck 1983; Ransley 1984; Verschueren 1983). More than 99% of the ethylbenzene produced in 1984 was used in

Table 4-1. Facilities That Manufacture or Process Ethylbenzene

STATE [a]	NUMBER OF FACILITIES	RANGE OF MAXIMUM AMOUNTS ON SITE IN POUNDS [b]	ACTIVITIES AND USES [c]
AK	2	100000 - 9,999,999	1, 3, 4, 8
AL	26	100 - 99,999,999	1, 2, 3, 6, 7, 8, 9, 10, 11, 12, 13
AR	18	100 - 999,999	1, 2, 3, 6, 7, 8, 11, 12, 13
AZ	2	100 - 9,999	8, 12, 13
CA	54	0 - 49,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
CO	4	100 - 9,999,999	1, 4, 6, 8, 12, 13
CT	8	1000 - 999,999	2, 3, 4, 6, 8, 10, 11, 13
DE	3	10000 - 49,999,999	1, 2, 3, 7, 8, 9, 12, 13
FL	12	1000 - 999,999	7, 8, 10, 11, 12, 13
GA	20	100 - 999,999	1, 2, 3, 4, 6, 8, 9, 10, 11, 12, 13
HI	2	1000000 - 9,999,999	1, 2, 6, 8
IA	16	100 - 999,999	2, 3, 8, 9, 10, 11, 12, 13
IL	74	0 - 49,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
IN	51	100 - 9,999,999	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13
KS	17	0 - 9,999,999	1, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13
KY	20	100 - 999,999	1, 2, 3, 4, 6, 8, 9, 10, 11, 12, 13
LA	41	1000 - 499,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13
MA	5	1000 - 99,999	8, 10, 11, 12, 13
MD	9	1000 - 999,999	8, 9, 11, 12, 13
ME	2	1000 - 99,999	12, 13
MI	55	0 - 9,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
MN	15	1000 - 99,999,999	1, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13
MO	31	100 - 999,999	7, 8, 9, 10, 11, 12, 13
MS	19	100 - 49,999,999	1, 6, 7, 8, 11, 12, 13
MT	4	100000 - 9,999,999	1, 3, 4, 6, 7, 8, 9, 13
NC	19	1000 - 999,999	1, 3, 5, 8, 11, 12, 13
ND	2	1000 - 9,999,999	1, 2, 3, 4, 7, 11
NE	5	100 - 99,999	8, 11, 12
NH	2	10000 - 99,999	8
NJ	28	1000 - 49,999,999	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13
NM	5	100000 - 9,999,999	1, 3, 4, 6, 7, 8, 9, 13
NV	2	1000 - 99,999	8, 9
NY	15	100 - 99,999	8, 9, 11, 12, 13
OH	75	0 - 49,999,999	1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13
OK	13	1000 - 49,999,999	1, 3, 4, 6, 7, 8, 9, 10, 11, 12
OR	6	1000 - 999,999	8, 10, 11, 12
PA	49	100 - 9,999,999	1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13
PR	6	100 - 999,999,999	1, 2, 3, 4, 5, 6, 8, 12, 13
RI	2	1000 - 9,999	11, 12, 13
SC	8	1000 - 99,999	8, 10, 11, 12, 13
SD	4	1000 - 9,999	8, 11, 12
TN	17	1000 - 9,999,999	1, 2, 6, 8, 9, 10, 11, 12, 13
TX	108	0 - 999,999,999	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
UT	8	100 - 99,999,999	1, 3, 4, 7, 8, 9, 10, 11
VA	14	1000 - 999,999	1, 3, 5, 6, 7, 8, 9, 11, 12, 13
VI	1	10000000 - 49,999,999	1, 2, 3, 4, 7
VT	1	10000 - 99,999	8
WA	14	100 - 9,999,999	1, 2, 3, 4, 5, 6, 8, 10, 11, 12, 13

Table 4-1. Facilities That Manufacture or Process Ethylbenzene (continued)

STATE [a]	NUMBER OF FACILITIES	RANGE OF MAXIMUM AMOUNTS ON SITE IN POUNDS [b]	ACTIVITIES AND USES [c]
AK	2	100000 - 9,999,999	1 , 3 , 4 , 8
WI	22	0 - 9,999,999	1 , 6 , 8 , 9 , 10 , 11 , 12 , 13
WV	15	1000 - 999,999	1 , 5 , 6 , 8 , 11 , 12 , 13
WY	6	1000 - 9,999,999	1 , 3 , 4 , 5 , 6 , 7 , 8 , 10 , 13

Source: TRI96 1998

[a] Post office state abbreviations used

[b] Range represents maximum amounts on site reported by facilities in each state

[c] Activities/Uses:

1. Produce
2. Import
3. Onsite use/processing
4. Sale/Distribution
5. Byproduct
6. Impurity
7. Reactant
8. Formulation Component
9. Article Component
10. Repackaging
11. Chemical Processing Aid
12. Manufacturing Aid
13. Ancillary/Other Uses

styrene production, while the remainder was exported or sold in solvent applications (HSDB 1995). Minor uses of ethylbenzene include use as a solvent, as a constituent of asphalt and of naphtha, and in fuels (ACGIH 1986; Merck 1983; Verschueren 1983). Ethylbenzene is also used in the manufacture of acetophenone, cellulose acetate, diethylbenzene, ethyl anthraquinone, ethylbenzene sulfonic acids, propylene oxide, and a-methylbenzyl alcohol (HSDB 1995; Verschueren 1983).

4.4 DISPOSAL

Regulations governing the treatment and disposal of wastes containing ethylbenzene are detailed in Chapter 7. Recommended methods for the disposal of ethylbenzene include burial in a landfill and rotary kiln incineration, liquid injection incineration, and fluidized bed incineration (Bonner et al. 198 1; HSDB 1995; IRPTC 1985). Ethylbenzene may be disposed of by adsorbing it in vermiculite, dry sand, earth or a similar material and then by burial in a secured sanitary landfill or by atomizing in a suitable combustion chamber (IRPTC 1985). Ethylbenzene is a good candidate for liquid injection incineration at a temperature range of 650-1,600 °C and a residence time of 0.1 to 2 seconds; a candidate for rotary kiln incineration at a temperature range of 820-1 ,600 °C and a residence time of seconds for gases and liquids and hours for solids; and a good candidate for fluidized bed incineration at a temperature range of 450-980 °C and a residence time of seconds for gases and liquids, and longer for solids (HSDB 1995).

The following waste water treatment technologies have been investigated for disposal of ethylbenzene; biological treatment, air and steam stripping, or activated carbon treatment (HSDB 1995). Spent ethylbenzene solvents and still bottoms from the recovery of these solvents are designated hazardous wastes and, as such, are subject to RCRA handling and recordkeeping requirements (EPA 1981b).

According to the Toxics Release Inventory (TRI), in 1996, a total of 11,860,593 pounds (5.3 million kg) of ethylbenzene were released to the environment (air, water, land, and underground injection) from 921 large manufacturing and processing facilities (TR196 1998). In addition, an estimated 58,872 pounds (26,704 kg) were released by manufacturing and processing facilities to publicly owned treatment works (POTWs) and an estimated 15,400,453 pounds (7.0 million kg) were transferred offsite (TR196 1998). No additional information was located on the trends in disposal methods related to ethylbenzene.